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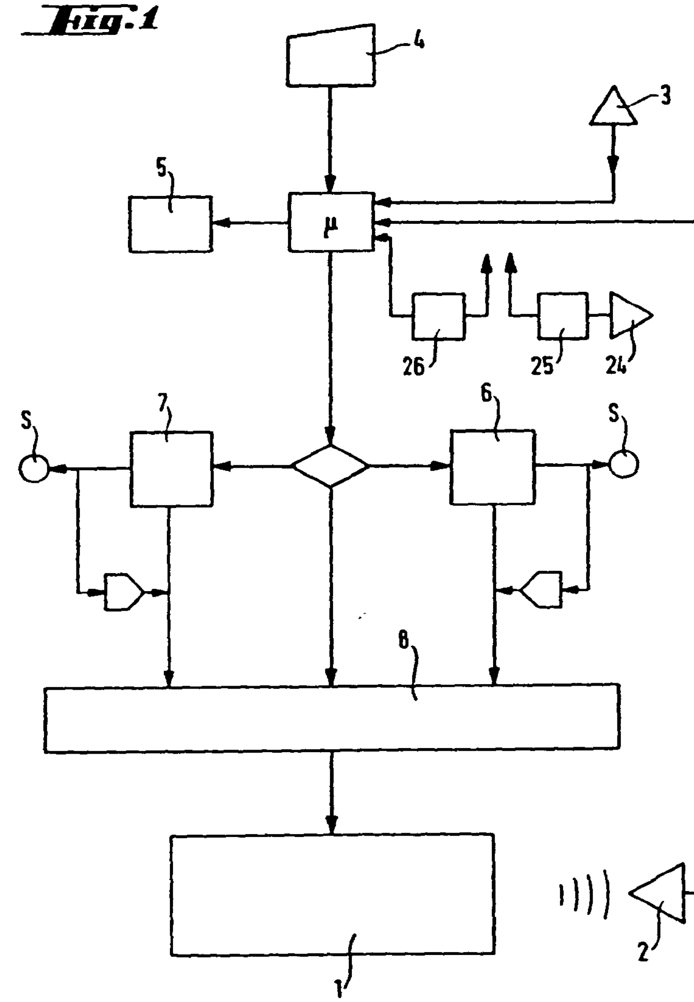
(54) **A method of temperature control of building materials**

(57) A method of controlling the temperature of mixed building materials wherein a mixer (1) is provided a heat detector (2) which signals a computer (μ) the temperature of the mix. The computer may also be fed with the amounts and temperatures of the components of the mix and calculates an amount of heat to be added or subtracted to give a desired temperature to the mix. Final control elements (6 and 7) add steam or ice water from storage devices (8) to the mix in accordance with the directions of the computer.

Fig. 1



GB 2 111 399 A

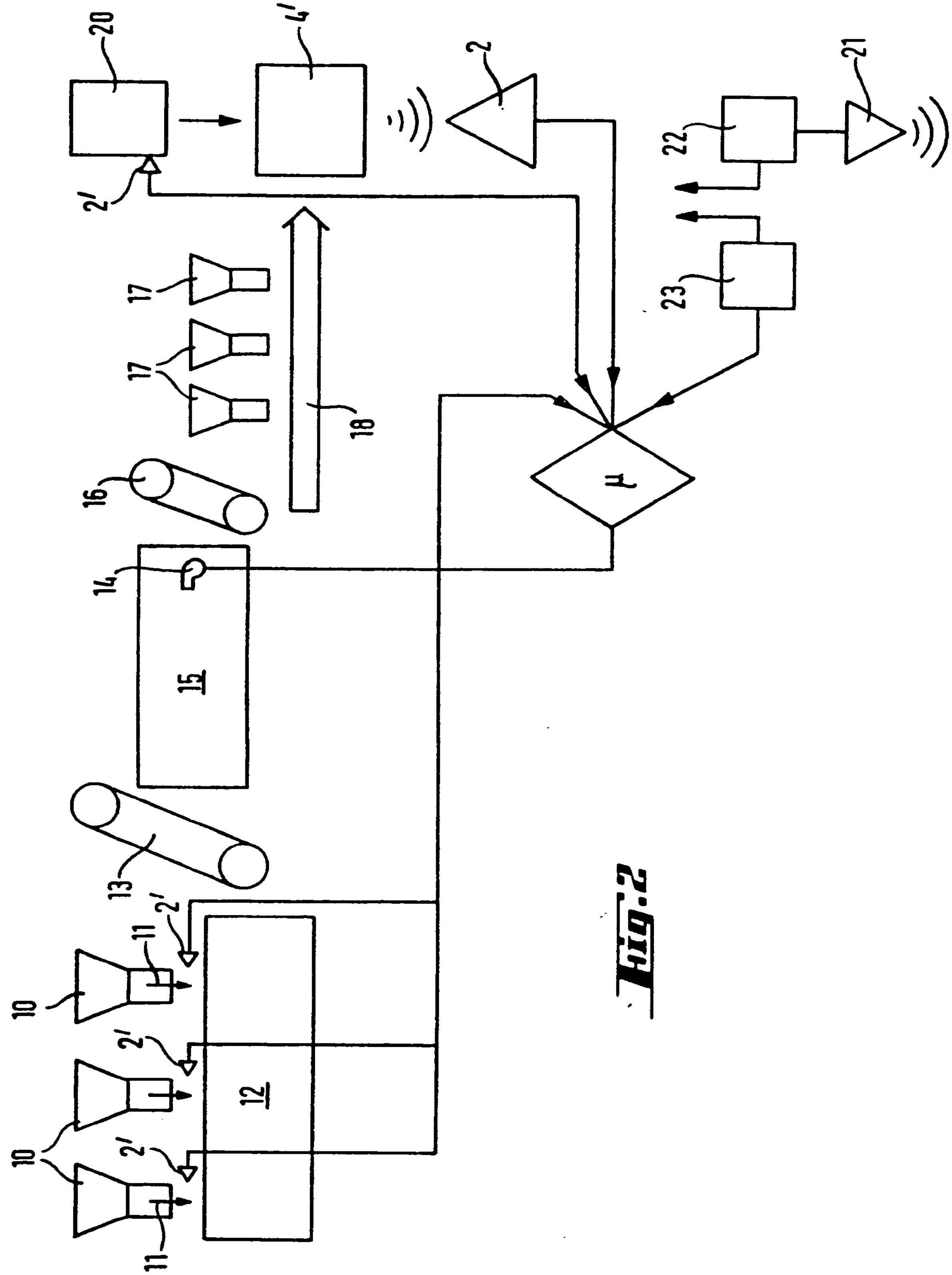


Fig.2

It should be assumed to be known that each mix is not absolutely like the preceding one or the following one, except in the formula. The base materials freely exposed to the weather in the course of the day, will change in composition depending on temp rature, rain and air humidity and the amount, as well as speed of use will produce different temperature conditions in the mixer. The water temperature alters, the aggregate temperature alters. The volume of the thermal energy to be supplied for the reaction must therefore be constantly adapted to these conditions.

For the starting of the hydration or of the cement crystallisation, and so for the course of hardening of the concrete, the temperature of the freshly mixed concrete is a functional criterion. It is equally decisive for the values of the early strength, the removal strength, the freezing strength depending on time for storage in the open, for the storability and ultimately for the economy of formwork, handling and utilization of space. The required values are fixed.

Since the temperature of the freshly mixed concrete and the heat of hydration are functionally dependent on electrochemical processes, it is possible to determine empirically which temperature of the freshly mixed concrete leads to the most economical starting situation in the production of cement concrete. The temperature conditions of the mix can be determined continuously and can be printed out through a recorder or signals can be given either optically/acoustically for a manually operated or automatically with direct pulse delivery to a final control element. As a result, it becomes possible not only to achieve precisely any required temperature of the freshly mixed concrete but to adhere to this precisely controlled from one mix to the next. The supply of steam does not replace the mixing water but serves to provide the starting temperature for the microprocess in the mix. Thus the method embodying the invention requires for the starting temperature of 27 °C of the freshly mixed concrete, starting from a water temperature of 8 °C instead of 50 °C, a supply of energy in the form of steam of up to 6700 kcal/cubic metre of concrete, with the following concrete formula:

Quality = B 550, fresh density = 2473 kg/m^3 cement = 440 kg/cm^3, W/Z = 0.43, water = 188 kg/m, aggregates = 1830 kg/m^3.

Once set to the temperature of the freshly mixed concrete, the installation controls this constantly for mix after mix. With this technical equipment, therefore, it is possible to draw the greatest possible use from the absolute minimum amount of cement.

The increase in and precise control of the starting temperature causes a more rapid start of the concrete hardening and avoids negative effects for the cement crystallisation which occur with other techniques.

An embodiment of the invention will now be more particularly described by way of example and with reference to the accompanying drawings, in which:

Fig. 1 shows a block diagram of a device which is suitable, in particular, for the production of hardening compositions with relatively low processing temperature; and

Fig. 2 shows schematically a device for producing hot plant mix.

In the form of embodiment shown in Fig. 1, the mix present in the mixer 1 is monitored by an infrared detector 2 disposed near a closable opening of the mixer 1, the infrared detector 2 being at a distance of about 1 to 2 m from the mix. In order to eliminate any influence of water vapour or CO_2 during the measurement, it has proved particularly advantageous to operate the infrared detector in the 8 – 14 μm band. A suction device may appropriately be provided in the vicinity of the closable opening in order to avoid soiling of the infrared detector 2. The accuracy of the temperature measurement with the infrared probe should amount to about $\pm$ 0.2 °C with a temperature range to be detected between 30 and 50 °C and a measuring time of 0.5 s. The infrared detector 2 is connected to a computer μ, and a reference value indicator 3 is provided for adjusting purposes.

The computer μ is further connected to a director 4 and a printer 5 serving as an indicating device.

Furthermore, the computer μ is supplied with analogue signals which correspond to the temperatures of the individual components of the mix to be mixed and the computer predetermines the heat content of the mix in accordance with the algorithm:

$$Q = \sum_i M_i * C_i * (t_o - t_i) + M_{zu} * q + Q^*$$

in which Q = heat content lacking in the mix

- i = component i, for example aggregates, cement, water bitumen etc.
- M_i = mass of the component i
- C_i = specific heat of the component
- t_o = desired temperature of the mix after the nd of the mixing operation
- t_i = initial temperature of the component
- M_{zu} = mass of the aggregates
- q = heat of fusion of the water (in th case of froz n components)
- Q^* = additional amount of heat in the case of a bituminous mix, which takes into consideration the fact that th t mp rature in the drying drum must be high r than t_o in the mixer.

instruments, such as infrared detectors 2', for example, detecting the temperature of the aggregates and of the bitumen, and controls the burner 14 and hence the supply of heat to the hot mix.

Because of the deficit in heat content of the aggr gat s, h at must be supplied to the aggregates via the burners so that Q_z^{soll} is present in the mixer. The corresponding h at content is calculated from the formula:

$$Q_{zu} = \Sigma M^i_{zu} \cdot C^i_{zu} (tsoll - t^i_{gem}) + Q^*_{zu}$$

in which:

M^i_{zu} = mass of the aggregate i

c^i_{zu} specific heat of the aggregate i

t^i_{gem} = measured temperature of the aggregate i (with 2')

tsoll = desired temperature of the hot mix

Q^*_{zu} = that amount of heat which the aggregates lose again between burner and mixer, its magnitude is specific to the installation and is determined by external influences such as weather, time of day, season of the year etc.

The computer μ calculates this additional heat content Q_{zu} necessary, on the basis of the measured data, with the above formula and in accordance therewith regulates the burner output or burning period of the burner according to the stored burner characteristic.

Furthermore, a continuous comparison of the desired temperature of the hot mix with the actual temperature of the hot mix detected by the infrared detector 2 is effected by the computer. If the actual temperature deviates from the desired temperature or from a predetermined tolerance range, the computer delivers correction signals for a further burner regulation.

The desired temperature t_{soll} of the mix, referred to in the above connection, can but does not have to correspond to the processing temperature t_v of the mix. Particularly in the case of producing bituminous surfacings, there may be a spatial distance of up to 10 km for example between the compacting operation, that is to say the production of the bituminous surfacing and the production of the hot mix in an installation as shown in Fig. 2. During the compacting operation, however, in order to achieve optimum results, a very specific processing temperature of 125—145°C for example should be adhered to. In order to ensure this, in a further development of the invention, the compacting machines may be equipped, for example in the region of the compaction rollers, with at least one temperature measuring instrument, for example an infrared detector for the measurement of the temperature of the hot mix. The output signal of this temperature measuring instrument is radioed to the computer μ which selects from a conformity table the desired temperature t_{soll} corresponding to this processing temperature and uses it as a basis for the calculating operation. In Fig. 2, this additional temperature measuring instrument and the associated transmitter and receiver unit is designated by 21, 22 and 23.

Thus, through the invention, too high or too low a temperature of the hot plant mix can be avoided, too high a temperature, causing increased oxidation of the bitumen, leading to an embrittlement of the applied bituminous surfacing, which corresponds to a free exposure to the weather of about 5 years, and too low a temperature leading to difficulties in compacting the surfacing, that is to say, to an increased cavity content and hence to a lower quality of the surfacing.

As a result of adjusting the required optimum processing temperature, a bituminous surfacing of high quality and constant cavity content is achieved with the optimum use of energy and as a result of the satisfactory compactability with a few passes.

In the same way as in the example of embodiment shown in Fig. 2, it is possible with that shown in Fig. 1 to adapt the desired temperature to the actual processing temperature. The temperature measuring instrument is there designated by 24, the transmitting and receiving unit by 25 and 26. In this case, the temperature measuring instrument 24 may appropriately be mounted adjacent to the discharge opening of a transport vehicle and the measurement is measured immediately before or during the output of the steam-cured concrete at the building site. Measurement via a separate opening in the transport container is naturally possible in the same manner. As a result of this additional possibility of adapting the desired temperature to the processing temperature of the mix, there is also the possibility, particularly in the provision of structures in which the introduction of the concrete extends over a relatively long period of time, of taking into consideration the lapse of time with regard to the incipient setting, that is to say the individual batches of concrete can b introduced with appropriately graduated processing temperatures in view of the setting of the first batch s introduced, which has already begun.

CLAIMS

1. A method of regulating th temperature during the production of building-material